## Executive Summary

A review of Task Assignment 94-6 identifies a number of areas where additional information would be very useful. The areas requiring further discussion are grouped into four categories: (a) Operational Impacts, (b) Storage Capacities and Data Rates, (c) Miscellaneous Uncertainties, and (d) Costs. Further work is recommended on the Operations Concept. It was not clear to what extent various facilities can continue to process old data while receiving new data. Results from some other Task assignments were not incorporated into this analysis. There was some mathematical carelessness but that is probably less important than the underlying assumptions. The effects of parallel processing and multiple spacecraft were not considered. Finally, although it is outside the scope of this study, it would be useful for there to be some discussion of how the deletion of Quicklook processing would affect the end user's ability to accomplish the scientific goals of the mission.

# 1.0    CUP REPORT 94-5 REVIEW

## 1.1    Background

The text for Task Assignment 94-6 reads as follows:

**Analyze Impacts of Not Performing Quicklook Processing**

**The contractor shall analyze the impacts of not performing Quicklook Processing in both the baseline and consolidated system.  This analysis shall identify impacts to the baseline and consolidated EDOS architectures, external and internal interfaces, changes to the baseline or consolidated functions in terms of effort, material, and ODC.  The contractor shall report on the implementation schedule impacts vs. the baseline and consolidated schedules.  The contractor shall document the impacts on the EDOS operations concepts, as modified in Tasks 94-1, 94-2, 94-3, and 94-4, and provide projections on required operations staff.**

The results of Task Order 94-6 are contained in a report (TRW 2700 94-6.00 Rev 1) dated November 4, 1994.

## 1.2    Objective

This document presents an engineering analysis of TRW Task Assignment 94-6 on possible elimination of Quicklook processing.  This analysis does not constitute a cost or technical audit of the TRW study.  The objective of this analysis is to answer the following questions:

1.  Does the study address all elements of the  task SOW?   Do they answer all  the questions?

2.  Are the assumptions reasonable?

3.  Does the study identify all of the technical and cost impacts?

4.  Are the answers valid?  Can the derivation of the answers be validated?

5.  Should the study have addressed additional or different topics?

6.  Does the study provide an adequate basis for NASA to make a decision?

## 1.3    Analysis

Specific comments below are grouped into four categories:  (a) Operational Impacts, (b) Storage Capacities and Data Rates, (c) Miscellaneous Uncertainties, and (d) Costs

**(a)    Operational Impacts**

- "Elimination of QDS quality checks" is listed on p. 9 as one of two Operational Impacts.  However, since there is no staffing impact from deleting Q/L functionality (p. 23), the elimination of QDS quality checks must not be a significant impact.
- For the same reason (no staffing impact), the need for no Q/L  data sets also must not produce a significant operational impact.

**(b)    Storage Capacities and Data Rates**

- The PDHF storage capacity of 250 GB (F&PS 6.2.2.5) includes up to 5% of the return link data in the form of Q/L, for a total of 105% of the original return link data. (The Q/L data is duplicated in the Production Data Sets.)  Without the Q/L data, therefore, the needed storage is 250 GB / 1.05 = 238.1 GB.  Then, the amount of savings from the deletion of Q/L data is 250 GB - 238.1 GB = 11.9 GB  — not 12.5 GB as stated on p. 26.
- The 1010 min. on p. 32 actually comes from the EDOS/Ecom Traffic Model which uses the required maximum delay for production data processing of 21 hrs (1260 min. — F&PR 4.1.2.2.2), not 1 day as stated on p. 32.  Then, allowing five minutes for DIF processing, 65 min. for DIF-to-DPF transmission, and three hours (180 min.) for DPF processing, yields:  1260 - 5 - 65 - 180 = 1010 min.
- Given an average aggregate instrument rate of 18.3 Mbps, the amount of data acquired in a 100 min. orbit can be written as 18.3 Mbps x 1.15 (O/H) x 1.25 (contg.) x 100 min. = 2.63 Gigabits.  To get the (PDS portion of the) DIF-to-DPF data transfer rate, this amount of data is, on p. 30, divided by 65 min.  The value of 65 min. came from one orbit (100 min.) less TSS time 30 min. and 5 min. delay.  The assumption here is that DIF must complete the data transfer before the next TSS.  Even if the DIF cannot *start* processing data until the TSS has ended, it still should be possible for the DIF to continue to process data from the previous TSS even while capturing new data during the next TSS.  If this is the case, then the DIF could spend essentially all 100 min. of each orbit processing data.  In that case, the required data rate for the PDS portion would be 26.3 Mbps instead of 40.5 Mbps.
- Similarly, the Q/L data rate could be 2.5 Mbps instead of 3.9 Mbps if the DIF can process old data while capturing new data.
- The total data transfer rate based on the TRW values, with Q/L and 50% contingency, would be 53.3 Mbps, not 3.3 Mbps as shown on p. 30.  This is presumably a typographical error.
- Calculation of reduction in data transfer rate from deleting Q/L (p. 12):
  - ◊ Using the TRW data rates of 40.5 Mbps for PDS alone and 44.4 Mbps total, the reduction would be (44.4 - 40.5) * 100 / 44.4 = 8.8%  (not 9.7% as shown on p. 30).
  - ◊ Using the rates on p. 31, the reduction from Q/L deletion would be (29.1 - 26.3) * 100 / 29.1 = 9.6%  (not 10.6% as shown).
  - ◊ Using the data rates shown on p. 32, the percentage reduction from the deletion of Q/L would be (40.3 - 37.4) * 100 /40.3 = 7.2%  (not 7.8% as shown).

- In the calculation for the PDS portion of the DPF output data rate, the total volume of data in one day [15.9 Mbps x 1.5 (contg.) x 1.1 (O/H) x 1440 min.] is divided by 1010 min. which, as discussed above, is (erroneously) described on p. 32 as "1 day less DIF proc time 5 min., DIF to DPF Xmit time 65 min., and DPF proc time 65 min." However, for continuous data transmission, the delays in DIF or in DIF-to-DPF transmission shouldn't matter because even though some data may still be in process in the DIF, previous data that has already gone through DIF can be in process in DPF. Thus, DPF processing can, in principle, occur almost continuously. The DPF processing rate will then be determined only by the input data rate and the DPF processing rate. So, instead of dividing by 1010 min., one should divide by 1260 min. (21 hrs) which is the required delivery time.

### (c)    Miscellaneous Uncertainties

- It is not clear why the value of 5% for Q/L overhead is "per the algorithm" (p. 25). The value of 5% is stated in the Operations Concept. Furthermore, exceptions to the 5% limit could be allowed, depending on the judgment of SMC Management and the consideration of possible degradation in EDOS support.
- The DPF processing time is given as 65 min. on p. 32. However, the EDOS/Ecom Traffic Model (12/18/92) uses a value of 3 hrs.
- Minor mathematical mysteries:
    ◊   A total of 29 "Peak Min" is given on p. 28, even though the individual values add up to 25.
    ◊   15.9 x 1.1 x 1.5  is, rounded to three significant digits, 26.2 — not 26.3 as shown in the first sub-bullet on p. 31.
    ◊   26.3 + 2.9 = 29.2, not 29.1 as shown in the third sub-bullet on p. 31.
    ◊   In the first sub-bullet on p. 32, the value of 1010 min. is said to come from 1 day (1440 min.) - 5 min. - 65 min. - 65 min.  This does not equal 1010 min.
- It is not clear why 25% contingency is used on p. 30 when p. 8 indicates that 50% contingency is assumed.
- An average aggregate instrument rate of 18.3 Mbps is used (p. 8, 30), whereas F&PR 4.1.1.1.9c gives an aggregate DIF-to-DPF rate for AM-1 of 17.3 Mbps — with 15% OH already included.
- On p. 31, 32, a data rate of 15.9 Mbps is assumed, whereas, F&PR 4.1.1.1.14 states 27.7 Mbps (already including 15% O/H). It is not clear why 15.9 Mbps is used.
- Why does the PDS portion of the DIF-to-DPF data rate on p. 33 (28.2 Mbps) not agree with the 18.3 Mbps that is assumed on p. 8 and used on p. 30?  There is a similar discrepancy for the Q/L portion. It would also be useful if an explanation were provided for the differences between the data rates on p. 33 and the Requirements (e.g., F&PR 4.1.1.2.89).

### (d)    Costs

- How much of the cost savings (p. 21) comes from hardware and how much from software? (There was no cost appendix in our copy of the document.)

## 1.4    Conclusions

1.  Did the study address all elements of the task SOW?  Did they answer all the questions?

    The analysis of the Operations Concept only involved locating all references to quick-look data and listing them for deletion.  This shows the impacts to the document, but not to the concept.  A technical analysis of impacts to the Operations Concept still needs to be done.

2.  Are the assumptions reasonable?

    There appeared to be the implicit assumption that the DIF had to complete the data transfer from one TSS before the beginning of the next TSS.  Similarly it was assumed that the DPF could not be processing older data while the DIF is processing newer data.

3.  Did the study identify all of the technical and cost impacts?

    Relevant results from other Task Assignments (94-1, 94-2, 94-3, 94-4) have not been addressed while analyzing the impacts of deleting the quick-look capability.  The report does not provide sufficient detail to independently validate the cost impact.

4.  Are the answers valid?  Can the derivation of the answers be validated?

    Where enough detail was provided, answers were checked.  While there was some degree of mathematical carelessness, the significance of the answers is probably affected more by the assumptions that underlie the calculations.

5.  Should the study have addressed additional or different topics?

    There was no analysis of data transfer rates either from the DIF to DPF or from DPF to its destinations given parallel processing capabilities and multiple spacecraft.  There was also no discussion of how the deletion of Quicklook processing would affect the end user's ability to accomplish the scientific goals of the mission.  This is outside the scope of this Task Assignment, but we mention it as a reminder to always keep the end user in mind.

6.  Does the study provide an adequate basis for NASA to make a decision?

    There are enough unresolved issues (summarized under the previous questions) that there does not yet seem to be an adequate basis for a decision.